

REMARKS

The Office Action dated April 6, 2007 has been carefully considered. Claims 1-11 are in this application.

The previously presented claims were rejected under 35 U.S.C. § 103 as obvious in view of U.S. Patent No. 6,252,110 to Uemura et al. in combination with of Kirk-Othmer and U.S. Patent No. 6,409,886 to Matsumoto et al. Applicants submit that Uemura et al., Kirk-Othmer, or Matsumoto et al. do not teach or suggest the invention defined by the present claims.

Uemura et al. teaches a method for recovering acrylic acid from high boiling impurities containing acrylic acid dimer, acrylic acid and maleic acid at high efficiency with stability which includes the steps of (1) introducing high boiling impurities containing acrylic acid dimer, acrylic acid and maleic acid into an acrylic acid recovery column, distilling acrylic acid from the column top and recovering the same, (2) introducing bottom liquid A from the acrylic acid recovery column into a pyrolyzing tank to decompose the acrylic acid dimer in the bottom liquid A, and (3) recirculating at least a part of bottom liquid B from said pyrolyzing tank into the acrylic acid recovery column. Accordingly, Uemura et al. teaches on a method wherein acrylic acid dimer and maleic acid-containing acrylic acid solution obtained from the bottom liquid of the purification step (high boiling impurities separation column 1) is subjected to distillation by introducing a distillation column 2. The bottom liquid of distillation column 2 is subjected to pyrolyzing process 4. Part of the bottom liquid of pyrolyzing tank 4 is withdrawn, and acrylic acid obtained from the top of distillation column 2 is recirculated to the high boiling impurities separation column 1 and high purity acrylic acid is obtained from the top of high boiling impurities separation column 1.

The Examiner indicated that Uemura et al. teaches introducing bottom liquid from a thin film vaporizer into pyrolyzing tank, decomposing acrylic acid dimer in a bottom liquid and thereafter recirculating at least a part of the bottom liquid of said pyrolyzing tank into said thin film vaporizer and/or the distillation column.

The acrylic acid recovery column in Uemura et al. is the combination of the distillation column 2 with the thin film vaporizer 3 (col. 3, lines 9-12) as shown in Exhibit A. The recovery of the acrylic acid from the pyrolyzing tank 4 by recycling is shown by the line from pyrolyzing

tank 4 to thin film vaporizer 3. The gas obtained from the top of distillation column 2 is recycled to the high boiling impurities separation column 1 (shown in double line). Therefore, the acrylic acid recovery column includes distillation column 2 and the thin film vaporizer 3 (circled by a one point dotted line).

In contrast, to the present invention, Uemura et al. do not teach or suggest step (j) of claim 1 of supplying the acrylic acid recovered by thermally decomposing said acrylic acid oligomer from step (i) to said azeotropic dehydration column. In the present invention, the acrylic acid recovered by thermally decomposing the acrylic acid oligomer in the pyrolyzing tank 51 is supplied to the azeotropic dehydration column 30 through a line shown by a double line from a top of column 46 to a top of the azeotropic dehydration column 30 (Exhibit B). The acrylic acid recovery column disclosed in Fig. 1 of Uemura et al. is circled by a one point dotted line which corresponds to distillation column 46 and thin film vaporizer 50.

However, in the present invention, gas of distillation 46 is not recycled to the high boiling impurities of the top separation column (heavy-ends cut column) 40 but is recycled to the azeotropic dehydration column 30. Accordingly, the acrylic acid recovery column of Uemura et al. is quite different from that of the present invention. One of ordinary skill in the art using the teachings of Uemura et al. would recycle the gas of the top of distillation column 40 to the high boiling impurities separating column (heavy-ends cut column) 40 as shown by a dotted line. However, in the present invention, there is no recycling from the distillation column 46 to heavy-ends cut column 40. Instead, according to step (j) in claim 1 of the present invention, the acrylic acid recovered by thermally decomposing said acrylic acid oligomer from step (i) is supplied to said azeotropic dehydration column 30.

Furthermore, there is no teaching or suggestion in Uemura et al. about the specific position for introducing the polymerization inhibitor and the specific combination (position) of the azeotropic distillation. Applicants submit one of ordinary skill in the art has knowledge for production of acrylic acid, in conventional systems, that the charging position of a polymerization inhibitor introduced for inhibiting polymerization of acrylic acid is either at a raw material charging step or a reflux liquid charging step. Uemura et al. teaches that the bottom liquid is obtained from the high boiling impurities separation column. While specific

composition of the liquid cannot be generally defined as it differs depending on the operation conditions selected for each of the processing steps, for example, the bottom liquid can consist of 20-65 weight % of acrylic acid, 30-60 weight % of acrylic acid dimer, 5-15 weight % of polymerization inhibitor (e.g., hydroquinone), 3-10 weight % of maleic acid, and other high boiling substances. (See col. 3, line 66 to col. 4, line 6). Accordingly, in the Uemura et al. process, the polymerization inhibitor is charged together with the feed liquid to the distillation column.

In contrast to the invention defined by the present claims, Uemura et al. do not teach or suggest introducing a polymerization inhibitor to the azeotropic dehydration column at any point between a point for supplying said aqueous acrylic acid containing solution and a point for supplying a reflux and not including the point for supplying said aqueous acrylic acid containing solution material and the point for supplying the reflux. Accordingly, in the present invention, the acrylic acid solution is used together with the polymerization inhibitor instead of the sole use of the inhibitor. It has been found that generation of polymerizate in the process of purification of acrylic acid can be considerably decreased by satisfying step (f) of introducing a polymerization inhibitor to the azeotropic dehydration column at any point between a point for supplying the aqueous acrylic acid containing solution and a point for supplying a reflux and not including the point for supplying the aqueous acrylic acid containing solution material and the point for supplying the reflux; and the step supplying the acrylic acid recovered by thermally decomposing the acrylic acid oligomer from step (i) to said azeotropic dehydration column.

The use of the solution provides recovered acrylic acid obtained by thermally decomposing the acrylic acid oligomer as shown by comparing Examples 1-4 with Comparative Examples 1-5 of the present invention. In Examples 1 and 2, shown in Table 1, even if the operation is carried out for not less than three months duration and tested for three months after, there is no problem in the azeotropic distillation column and in the thin evaporator, the waste oil content is low and there is low water and the high boiling substance contents are low. Further, in Example 3, the solution is used solely without mixing the solution of the polymerization inhibitor with a top liquid of maleic acid separation column, and it is charged beyond the raw material supply point of the azeotropic dehydration column and is supplied from the reflux liquid

to the column and then the top liquid of the maleic acid separation column is supplied to the azeotropic dehydration column, and there is no problem in the high boiling substance separation column and the thin film evaporator, an amount of waste oil and water and high boiling substance contents are low. However, the top liquid of the maleic acid separation column is not mixed and used as the aqueous solution of the polymerization inhibitor, there is no precipitation of the polymerizate although some of the polymerization inhibitor precipitates at the region of the polymerization supplying point in the azeotropic dehydration column for one month operation.

On the contrary, in Comparative Example 1, there is no problem in the high boiling substance separation column and the thin film evaporator, and an amount of the waste oil and water and the high boiling contents are low, but if steps (f) of introducing a polymerization inhibitor to said azeotropic dehydration column at any point between a point for supplying said aqueous acrylic acid containing solution and a point for supplying a reflux and not including the point for supplying said aqueous acrylic acid containing solution material and the point for supplying the reflux and (j) of supplying the acrylic acid recovered by thermally decomposing said acrylic acid oligomer from step (i) to said azeotropic dehydration column are not carried out, there is a defect in that the polymerizate precipitates at the point over the aqueous solution supplying point in the azeotropic dehydration column for two months operation when the detection was carried out for about after two months. Further, in Comparative Example 2 (Examples 5-7), if both a precipitation of steps (f) and (j) are not carried out, such that the bottom liquid of the heavy ends cut column is directly supplied to the thin film evaporator and the acrylic acid recovered from the evaporator is circulated to the heavy ends cut column, fumaric acid is formed in both the high boiling substance separation column and the thin film evaporator. Also, there was precipitation of the polymer azeotropic and the polymerization inhibitor in the dehydration column. The waste oil and water and high boiling substance content increased for one month of operation. The detection of the precipitation was carried out after stopping operation after one month. Accordingly, the invention defined by the present claims is not obvious in view of Uemura et al.

Matsumoto et al. teach a method for inhibiting polymerization of any easily polymerizable compound contained in the liquid by spraying the liquid at the distillation column. However, Matsumoto et al. do not teach or suggest the step of supplying the acrylic acid recovered by thermally decomposing an acrylic acid oligomer to an azeotropic dehydration column and do not cure the deficiencies of Uemura et al. noted above.


Kirk-Othmer teach to feed polymerization inhibitors to the process. However, Kirk-Othmer do not teach or suggest the step of supplying the acrylic acid recovered by thermally decomposing an acrylic acid oligomer to an azeotropic dehydration column.

Accordingly, neither Uemura et al., Kirk-Othmer, or Matsumoto et al. teach the step of supplying an acrylic acid recovered by thermally decomposing the acrylic acid oligomer to an azeotropic dehydration column and the invention defined by the present claims is not obvious in view of Uemura et al. in combination with Kirk-Othmer or Matsumoto et al.

In view of the foregoing, Applicants submit that all pending claims are in condition for allowance and request that all claims be allowed. The Examiner is invited to contact the undersigned should he believe that this would expedite prosecution of this application. It is believed that no fee is required. The Commissioner is authorized to charge any deficiency or credit any overpayment to Deposit Account No. 13-2165.

Respectfully submitted,

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